Requirements Capabilities & Analysis for Earth Observations

User Requirements for Land Imaging and SLI

Winter Landsat Science Team Meeting, 2016

Purpose of RCA-EO

The Requirements, Capabilities and Analysis for Earth Observation (RCA-EO) Project was established to:

- Evolve USGS products and services based on user requirements

- Identify Earth observation solutions to meet user requirements or identify capability gaps (unmet needs)

- Inform development of the Sustainable Land Imaging program missions

- Complement stakeholder engagement mechanisms such as the Landsat Science Team

- Support program planning and budget prioritization

What are User Requirements?

– The specification of an observed feature and necessary attributes, including spatial and temporal resolution, accuracy, geographic coverage, latency, etc.

– Technology independent; so that requirements can be mapped to multiple land imaging technologies

– Requirements nomenclature based on NASA Global Change Master Directory (GCMD) lexicon

- Primary attributes of a user requirement
  - Environmental Parameter (what needs to be observed or measured)
  - Geographic Coverage
  - Horizontal Resolution
  - Vertical Resolution (if applicable)
  - Sampling Interval
  - Accuracy

  - For each of these attributes we capture a value, the units, and comments/rationale for the chosen values (to the degree the SMEs are able to provide the information)

Some Examples:

Environmental Parameter	Geographic Coverage	Horizontal Resolution	Temporal Frequency
Elevation	CONUS	10 m	10 yr
Vegetation Condition	Alaska	30 m	2 wk
Sea Surface Temperature	Global Ocean	30 km	12 hour
Soil Moisture	Global Land	1 km	1 wk
Snow Cover Extent	North America	20 m	1 wk (Dec-Apr)

User requirements capture "what", "where", "when", and "why" but not "how"

- RCA-EO will also capture information about:

  - **Length of the Data Record** (whether backward calibration of the data record is important to the application, and if so, the length of the record that is relevant/desired)

  - **Data Latency** (whether it's important, and if so, how quickly they need the data after collection)

  - **Conditions for Sampling** (day/night, time of day, snow cover, leaf on/leaf off, etc.)

User Requirements

- RCA-EO will also capture information about:

  - **Spectral Characteristics**

    - Unmet needs, enhancements to what's currently available

      - This can be new bands or specifications about current bands (number of bands within a spectral region, band placement and/or width, the desire for hyperspectral, etc.)

  - **Data Services, Access and Formats**

    - Capture comments about satisfaction with current sources/formats of data (already have some of this via the Value Tree Information data collection)

    - Capture thoughts about improvements

- For each requirement there are 3 potential levels:

  - **Threshold**

    - The minimum specification to be met to ensure that an Earth observation (EO) dataset or service is useful

  - **Breakthrough**

    - An intermediate requirement level which, if achieved, would result in a significant improvement in capability against the targeted application

  - **Target**

    - The value above which further improvement of the EO dataset or service would provide only limited improvement in performance for the application in question

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Environmental Parameter (EPs)		Secondary Aspects (samples)
1	Land Cover	Vegetation Type
		Crop Type
		Land Use/Land Cover Classification
2	Vegetation Condition	Vegetation Index/Disturbance
		Vegetation Stress/Vigor
		Vegetation Fraction: Green
3	Vegetation Structure	
4	Forest Composition	
5	Burned Area Extent	Burn Severity
		Vegetation Disturbance
6	Biomass: Vegetation	
7	Terrain Elevation	Topography
8	Land Skin Temperature	
9	Surface Reflectance	Albedo
10	Surface Water Extent	Flood Area/Boundary
11	Surface Water Clarity	Quality/Light Transition/Chlorophyll
12	Snow Cover Extent	
13	Glacier Extent	

- **FY16 Requirements collection to include key land imaging activities within:**
  - USGS, USDA, BLM, BOR, FWS, NPS, NASA and potentially other agencies

- **USDA applications & subject matter experts to be surveyed (examples only):**
  - **NRCS:** Crop Residue Management Surveys, Soil Survey Interpretation Maps, National Resource Inventory (NRI); Sample SMEs: Dorsey Plunk, Tony Kimmet, Dan Good, Dave Hoover
  - **FAS:** Global Crop Area/Yield Estimation, Rapid Response to Global Agricultural Crises; Sample SMEs: Bob Tetrault, Curt Reynolds, Glenn Bethel
  - **RMA:** Actuarial Rate Maps, Compliance Monitoring Investigations; Sample SME: Jim Hipple
  - **NASS**: National Crop Yield Forecasting Sample SMEs: Rick Mueller, David Johnson
  - **ARS:** ET Anomaly Mapping, National Watershed Climate Change; Crop Residue Monitoring; Sample SMEs: Martha Anderson, Craig Daughtry, Mark Walbridge
  - **Forest Service:** Global Forest Resource Assessment, Fire Products (BAER/BARC, MTBS, RAVG, Active Fire Mapping, Spatial Fire Behavior Models, etc.), Forest Disturbance Assessment, National Insect and Disease Risk Mapping, Forest Inventory and Analysis; Sample SMEs: Brad Quayle, Greg Dillon, Jim Ellenwood, Frank Krist, Frank Sapio, Bob Ilgenfritz

Requirements Collection Plans

- 2016 focus is on capturing requirements for a broad range of land imaging application areas

  - Focus on operational and science applications where <u>land imaging</u> is a key data input

  - Consider multiple datasets and product needs, including Landsat as one of multiple possible sources

  - Work with Landsat team to identify any missing applications and supporting requirements

  - Cross-check priority applications areas being identified by the OSTP Earth Observation Assessment

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Formal task with Fort Collins (FY16) to:

- Examine any gaps in our federal civil applications, and unique non-Federal requirements

    - Using current EROS Earth Explorer data and Landsat User Survey data to further characterize the unique/under-represented applications and how important Landsat is to those applications

- Assess any major differences in applications between U.S. and international users (EROS and Fort Collins data)

- Develop additional requirements collection plans as needed

Broad Uses of Requirements

LRS plans to collect and maintain a database of user needs and requirements to:

- Understand and characterize the needs of diverse user communities

- Identify gaps to determine if there are under-represented user groups

- Inform future program / system direction

  - System design and development (resolution, revisit, etc.)

  - Services design/delivery and product generation

  - High-impact applications, e.g., Land Change Monitoring, Assessment, and Projection (LCMAP), carbon, agriculture, etc.

Requirements Analysis

- Questions that can be addressed with requirements combined with observing systems (current or planned)

    - What requirements are met or partially met by an existing or planned capability? Which are not?

    - What system alternatives are potentially available (or might be proposed) to meet user requirements or to fill gaps in requirement satisfaction?

    - Which key attribute(s) most limit performance in meeting a particular set of needs

    - Identify areas for improvement/enhancement in products/data/systems to best meet user needs

SLI Mission Development

- RCA-EO-collected user requirements can support SLI technology and mission development

- Some considerations in deciding the "best" place to invest in L-10

  – Identify key requirements associated with science research and operational applications

  – Serve current applications and expanded communities of use

  – Balance science/application utility with expected technology development risk and cost

- RCA-EO requirements data could

  – Identify "sweet spots" between new instrument/technology and user requirements (met/unmet) to guide development decisions

  – Inform new technology investigation priorities for L-10

User Requirements - Next Steps

- Full up requirements collection, leveraging EOA 2016 schedule

- Monitor and make our data collection processes more efficient over time

- Near-term plan for use of requirements:

  - Insights for LCMAP development

  - Early requirements from DOI to help inform NAIP contract specifications

  - Initial phase requirements to inform SLI technology investigations (June 2016)

  - Other LRS business uses such as portfolio management and new initiatives

RCA-EO will provide:

- Summary of land imaging requirements met by current Landsat systems

- Initial summary categories of candidate unmet needs for Landsat 10 / SLI consideration

- Evaluation of impact of an increase in sensor capability in meeting selected requirements

- A list of surveyed subject matter experts (LST may want to provide other key researchers for RCA-EO to contact)

- Discuss other analyses of interest to the LST research agenda and activities

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- Spring - Review of requirements collection plans and recommend any additional applications or subject matter experts, if needed

- Summer

  - Review RCA-EO requirements sampling method based on findings of Fort Collins study characterizing the uniqueness of Federal civil versus non-federal needs

  - Identify information/analyses that RCA-EO could provide to the LST: includes requirements and capabilities studies; linking of current requirements to alternative capabilities; identifying potential collaborators based on sensor or application; assessing requirements satisfaction for notional capabilities; conducting data gap studies based on alternatives to Landsat, etc.

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